

REMARKS

The abstract and specification have been amended in order to correct grammatical and idiomatic errors contained therein. No new matter has been added.

In order to expedite the prosecution of the present application, the subject matter of objected-to Claims 3 and 6 have been incorporated into Claims 2 and 5, respectively. Accordingly, Claims 3 and 6 have been canceled. No new matter has been added.

Claims 1, 2, 4 and 5 have been rejected under 35 USC 103(a) as being unpatentable over Tsujii et al. Applicants respectfully traverse this ground of rejection and urge reconsideration in light of the following comments.

The presently claimed invention is directed to an alloyed steel powder having an improved degree of sintering which is used in metal injection molding. The powder consists of, in mass percentages, 0.1 to 1.8% carbon, 0.3 to 1.2% silicon, 0.1 to 0.5% manganese, 11.0 to 18.0% chromium, 2.0 to 5.0% niobium and the balance being iron and unavoidable impurities. The present invention is also directed to an alloyed steel sintered body having the composition of the alloyed steel powder discussed above.

As explained in the instant specification, the present invention is concerned with the manufacture of an alloyed steel powder which is used in metal injection molding and can form complex shaped parts of very hard, highly corrosion-resistant martensite stainless steel for tools of alloy steel having a good dimensional precision. Conventional alloys used as metal injection molding powders are steels exhibiting an austenite phase in the sintering temperature range and have a poor degree of sintering due to the speed of elemental diffusion which promotes sintering being slower than in a ferrite phase. However, if the temperature is raised to the temperature at which a liquid phase appears in order to promote sintering, a large amount of the liquid phase arises

at once and carbides are formed as networks at the grain boundaries resulting in either the strength of the product being seriously diminished or being deformed to the point that the shape of the product cannot be maintained. To avoid these problems, the sintering temperature is controlled within an extremely narrow temperature range of $\pm 5^{\circ}\text{C}$. Therefore, it has been necessary to limit the useful region of the sintering furnace which ends up in a loss in productivity.

The present invention overcomes the problems of product strength and difficulty in controlling sintering temperature by providing an alloyed steel powder which consists of, as mass percentages, 0.1 to 1.8% carbon, 0.3 to 1.2% silicon, 0.1 to 0.5% manganese, 11.0 to 18.0% chromium, 2.0 to 5.0% niobium and the remainder being iron and unavoidable impurities. In the present invention, niobium plays an essential role during sintering. Niobium carbide, which does not easily diffuse, is produced in the steel including chromium carbide, which is likely to diffuse. The niobium carbide exhibits a fixing effect to prevent bulking and network formation of the carbide in the sintered body, which contributes to the improvement of easy sintering temperature control and productivity. The present inventors discovered that the optimum content ratio of niobium in the present invention is 2.0 to 5.0 wt.%. The effect of niobium isn't sufficient if the content amount thereof is less than 2.0% while if it exceeds 5.0%, the amount of oxygen increases and the moldability is adversely affected. As such, it is respectfully submitted that the presently claimed invention is not disclosed by the prior art cited by the Examiner.

The Tsujii et al reference discloses a method of producing a corrosion-, heat- and wear-resistant member which comprises the steps of packing an atomized powder of a high-carbon high-chromium steel into a capsule, heating the capsule packed with the powder and then extruding the capsule packed with the powder to obtain a stock not containing carbide grains greater than 3 microns. The stock is worked, a surface

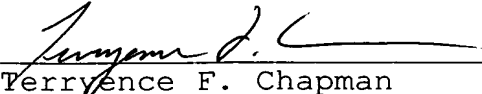
of the stock polished and a film of titanium carbide and/or titanium nitride evaporated onto the polished surface and the member manufactured therefrom.

The Tsujii et al reference is mainly focused on the coating provided on the stock material as opposed to the stock material per se and it is mainly concerned with the prevention of flakes or breaks in the coating. For the parent stock material, the Tsujii et al reference only suggests a strict control of the particle diameter. This reference has no discussion with respect to sintering temperature control and productivity of the steel, which are problems solved by the present invention. Since niobium is an optional ingredient in the alloy of Tsujii et al, this reference has no disclosure with respect to the criticality of forming niobium carbide during sintering which is a critical aspect of the present invention. Therefore, Applicants respectfully submit that the use of niobium in the present invention is completely unobvious in light of the disclosure of Tsujii et al.

In Tsujii et al, the method of producing the parent stock material is completely different from the method of producing the sintered body of the present invention. In Tsujii, the method of producing the parent stock material is classified into four processes: (1) melting and casting the material and then rolling, (2) powder, then press compacting, sintering and HIP, (3) powder, then capsule packing, HIP and drawing, and (4) powder and then capsule packing, glass-lubricated hot extrusion. In contrast thereto, the present invention requires that the starting material powder be kneaded at 80°C, cooled and solidified into pellets. The pellets are then pulverized, press-molded and sintered. Therefore, the process of performing the sintered body of the present invention is expressly different from that disclosed in Tsujii et al.

The Examiner is respectfully requested to reconsider the present application and to pass it to issue.

Respectfully submitted,


Terryence F. Chapman

TFC/smd

FLYNN, THIEL, BOUTELL	Dale H. Thiel	Reg. No. 24 323
& TANIS, P.C.	David G. Boutell	Reg. No. 25 072
2026 Rambling Road	Terryence F. Chapman	Reg. No. 32 549
Kalamazoo, MI 49008-1631	Mark L. Maki	Reg. No. 36 589
Phone: (269) 381-1156	Liane L. Churney	Reg. No. 40 694
Fax: (269) 381-5465	Brian R. Tumm	Reg. No. 36 328
	Steven R. Thiel	Reg. No. 53 685
	Donald J. Wallace	Reg. No. 43 977
	Sidney B. Williams, Jr.	Reg. No. 24 949

Encl: Marked-Up Substitute Specification
Clean Substitute Specification
Replacement Abstract
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